

**Question 1**

**Q** Were the soldiers in the weapons testing program 'volunteers'? What were they told about the risk involved?

**A** Generally, the uniformed military personnel involved in the U.S. atmospheric nuclear weapon testing program were not volunteers; however, there were exceptions. The following paragraphs outline the major participant groups and discuss their status.

Military personnel were assigned at almost every echelon of the complex and changing organization which conducted the atmospheric testing of nuclear weapons--beginning with the TRINITY detonation at Alamogordo, New Mexico, during World War II (1945), and ending with Shot TIGHTROPE of Operation DOMINIC I in the Johnston Island area (1962). There were 235 atmospheric nuclear tests spanning some 17 years of testing, principally in the Pacific and at the Nevada Test Site.

Military scientists, technical specialists, and other professionals were assigned to the weapons laboratories of the Atomic Energy Commission (AEC)--the Los Alamos Scientific Laboratories, the University of California Radiation Laboratories, and the Sandia Corporation--which were concerned primarily with the key functions of nuclear weapons development and diagnostic experiments. Military personnel formed the bulk of the Armed Forces Special Weapons Project (AFWSP) which performed a variety of nuclear weapons effects studies on items of military interest. Military scientists and technical specialists augmented the Federal Civil Defense Administration (FCDA), which conducted civil defense nuclear weapons effects experiments. Additionally, teams of scientists from a variety of Federal research facilities, often consisting at least partially of military personnel, performed experiments in support of all organizations at the test sites. Examples of these research facilities are Oak Ridge National Laboratory (ORNL), the Army Ballistics Research Laboratory (BRL), the Air Force School of Aerospace Medicine (AFSAM), and the Naval Radiological Defense Laboratory (NRDL).

All other military participants generally fall into two categories: (1) members of existing military units which were moved intact from their home station to a test site to perform a training or support mission; and (2) those who were sent individually to a test site, many of whom were formed into composite units upon arrival. There is little doubt that members of intact military units, which were sent to test sites to perform missions commensurate with their organizational purpose, were not given the opportunity to volunteer. Conversely, contact with many of the participants indicates that at least some of the individually selected personnel were given the opportunity to volunteer for quotas assigned to home installations.

Since early 1978, the Defense Nuclear Agency (DNA) has been the Department of Defense (DoD) executive agent for a high-priority program designed, in part, to identify all DoD test participants and to reconstruct their radiation dosages. Over 69,000 individuals have contacted DNA, via toll-free telephones established for the purpose of reporting participation in an atmospheric nuclear test and/or the occupation of Hiroshima/Nagasaki. Many callers have proven to be invaluable sources of information for reconstructing a personnel-oriented history of U.S. nuclear weapons testing and development. A review of the records and reports of atmospheric nuclear weapons tests indicates that considerable effort was devoted to ensuring participants were aware of the hazards and risks associated with radiation, as these were then known. Certainly, some personnel were better trained than others, depending on the functions to be performed.

Over the 17-year period of testing at oceanic and continental test sites, a variety of educational methods were used, ranging from attendance at formal service radiological schools to short observer training and indoctrination courses conducted for transient observers. Some troop units conducted orientation courses at home stations before arrival at the test site where more extensive indoctrination was carried out. Often, safety and information booklets were distributed, and extensive pre-shot rehearsals and pre-shot visits to the equipment display areas--accompanied by briefings--were conducted. At the DESERT ROCK observer trench or viewing areas, special instruction was provided via public address systems right up until a few seconds before shot time; and instruction resumed immediately following passage of the light flash.

The organization for testing at oceanic test sites was constructed around a Joint Task Force, principally to facilitate complex logistics support; and the organization for continental testing centered about the AEC Test Manager's organization. Military units and individuals were assigned to these organizations to perform necessary administrative, logistical, and operational functions such as land, sea, and air transportation; port operations; finance, subsistence; recreation; maintenance; and communications.

Beginning with the BUSTER-JANGLE series (1951) and continuing through Operation PLUMBBOB (1957), a series of military exercises was conducted under the purview of the Commanding General, Sixth U.S. Army. These programs, termed Exercises DESERT ROCK I-VIII, were conducted for the purpose of training and indoctrinating military personnel concerning expected future military operations on an atomic battlefield. They consisted primarily of maneuver exercises, observer orientations, and technical weapons effects experiments. Participation in DESERT ROCK exercises consisted almost entirely of uniformed military personnel.

The only group of military personnel which were exclusively volunteers in the strictest sense of the word were participants in the DESERT ROCK Volunteer Observer Program (Officer Volunteers). Members of this group, totaling about 42 personnel, each observed one or more selected detonations at the Nevada Test Site in the years 1953, 1955, and 1957. These groups were generally closer to ground zero at the time of detonation than any other participants. The primary purpose of the Volunteer Observer Program was to

obtain recommendations concerning whether troops could physically and psychologically continue to perform assigned missions in wartime after atomic detonations in close proximity to their defensive positions. Participants in the program were personnel who, by training and experience, were capable both of understanding the risks involved and of calculating the minimum safe distances involved. Indeed, our records indicate that each volunteer was required to perform the safe distance calculations, and each was required to sign a statement acknowledging that he was a volunteer before being allowed to participate.

During Exercises DESERT ROCK I-III at the Nevada Test Site (1951), instruction was provided by members of the AEC and AFSWP. Responsibility for instruction gradually phased to a specially trained Camp Desert Rock Instructor Group, which, from the time of DESERT ROCK V (1953) and onward, carried out this function. A review of training schedules and after-action reports indicates that typical subjects presented were nuclear weapons characteristics; nuclear weapons blast, heat, and radiation effects; the medical aspects of atomic energy; defensive measures and individual safety precautions; methods of decontamination; emergency evacuation plans; the duties of radiation safety teams; and marking of contaminated areas.

Regarding the information given to troops concerning the radiation exposure levels they would experience, review of records shows that they were generally given information falling into three categories:

- (a) The permissible exposure levels which had been established for the exercise, shot, or series (in rem).

- (b) The extensive precautions that were being taken (safe standoff distances, continuous meteorology monitoring, safe stay-time calculations, alternate plans for changed conditions, pathfinders and monitors to pre-survey troop movement areas, film badges and monitors during movement, decontamination if necessary, etc.) to ensure that their radiation exposure remained within these permissible exposure levels.

- (c) The fact that medical science was confident no adverse effects would result from exposures at the permissible level.

In retrospect: (a) the permissible levels established were generally in close accord with existing national and international standards; (b) the safety precautions were quite effective in keeping most exposures well below the permissible levels; but (c) medical science today is not as confident as it was in the 1950's that very low doses have no adverse effect upon health. Scientific opinion today is divided, and while it is generally accepted that there is no "safe" dose of radiation, and that the risk from low doses (i.e., a few rem) is very low, the exact dose-effect relationship is still under intensive study.

### Question 1a

**Q** Are the postwar occupation troops of Hiroshima and Nagasaki, Japan, accounted for in DNA's program?

**A** Our program has been responding to inquiries regarding the occupation forces since 1978. On May 20, 1988, Public Law 100-321, "Radiation-Exposed Veterans Compensation Act of 1988," was enacted. The VA, in its implementing regulations of this law, defined the occupation of Hiroshima and Nagasaki, Japan as:

"official military duties within 10 miles of the city limits of either Hiroshima or Nagasaki, Japan, which were required to perform or support military occupation functions such as occupation of territory, control of the population, stabilization of the government, demilitarization of the Japanese military, rehabilitation of the infrastructure or deactivation and conversion of war plants or materials."

Former prisoners of war who were interned within 75 to 150 miles of Hiroshima or Nagasaki city limits, respectively, or were repatriated through Nagasaki, were also considered eligible participants by the VA.

As a result of PL 100-321, we began actively researching the identification of individuals involved in the occupation. To date, approximately 195,000 Hiroshima and Nagasaki participants have been identified and entered into our database.

## Question 2

**Q** Did the film badges of the soldiers who received compensation due to radiation exposure from the WARRIOR Test Series show an 'average' dose? If not, what were the doses received? I believe it was stated that the majority of the soldiers who were compensated showed signs of radiation exposure; i.e., nausea and burns. Wouldn't this indicate a much higher dose? Were these soldiers in one group? Were they the designated 'film badge wearers' for larger groups of soldiers who individually didn't have badges? How many soldiers who were in the same groups as those given compensation, asked for and been refused compensation?

**A** The Department of Veterans Affairs (VA) is responsible for questions relative to claims and considerations for awarding compensation. According to the most recent statistics provided by the VA, 400 participants have been awarded compensation under PL 100-321; approximately 70 (no more than 100) veterans have been awarded compensation under PL 98-542; a total of 1400 cases have been positively adjudicated for which radiation has been put at issue, however, the award may not have been based on radiation exposure.

Film badges do not measure an 'average' dosage. A single badge will measure cumulative exposure during the entire period of issue; and, without additional information, it is not possible to determine whether an exposure recorded by a single badge occurred during a single instance or on a number of occasions during the period of issue. Accordingly, procedures at the test sites required that trained radiation monitors accompany groups entering contaminated areas to maintain a continuous status of exposure accumulation and to require the exchange of film badges when necessary. Most personnel turned in their film badges every few weeks for processing, but exact timing depended on length of assignment, individual job, activity and exposure.

We are not informed of the final disposition of individual claims under the VA medical and adjudication process, and therefore, in the main, cannot provide correlating statistics. However, in the case of Task Force WARRIOR (consisting of elements of the 1st Battle Group, 12th Infantry and supporting units) that maneuvered at the Nevada Test Site in support of Shot SMOKY, August 31, 1957; we learned that one member has received compensation. His recorded dose was 0.755 rem gamma, 0.56 rem of which was received during rehearsals and observation of shots prior to SMOKY, and 0.195 rem of which was received in conjunction with the SMOKY maneuver.

Another participant in the SMOKY test (who was not in Task Force WARRIOR) was also awarded compensation. This individual was part of a provisional company from the 82d Airborne Division which, although present at the test site during a portion of the same time period as Task Force WARRIOR, participated in a different exercise. The recorded dose for this individual was 1.25 rem gamma.

Exposure records for the majority of Task Force WARRIOR personnel show two film

badge issue periods: July 25 - August 27, 1957 (the rehearsal and preparation period) and August 27 - September 2, 1957 (the period of the SMOKY maneuver). The combined dosages for both periods for all Task Force participants average 0.575 rem, with the range extending from a low of about 0.05 rem to a high of about 1.4 rem. The badge issue period for the 82d Airborne Division provisional company was August 13 - September 3, 1957. The badge readings average 1.295 rem, and the range extends from zero to about 3.0 rem. Thus the two SMOKY participants who received compensation had recorded doses which were very close to the average of the recorded doses for all men of their units.

DNA has not been able to determine the source of the quoted sentence in Question 2 which states: "I believe it was stated that the majority of the soldiers who were compensated showed signs of radiation exposure, i.e., nausea and burns." The extensive test reports we have reviewed show no indication that nausea and burns were anything but rare individual occurrences--and unconnected with the prompt radiation or thermal effects of detonations. Of the VA awards to date, we know of only two that experienced burns, and there is no indication of nausea. The two burn cases occurred aboard the USS BAIROKO during Operation CASTLE at Bikini Atoll (March 1954), and have no relationship to the Task Force WARRIOR maneuver. The two burns were not thermal burns caused by prompt radiation from the fireball, but rather came from beta particles in fallout.

It is appropriate to discuss briefly this distinction between thermal burns (which would occur at the moment of detonation) and radiation burns (which would be caused by fallout--a delayed effect). Thermal burns result from heat that is produced at the time of detonation. This heat causes injury due to increase in skin temperature; and it is similar to a burn caused by touching a hot object or being exposed to fire of any origin.

Burns associated with ionizing radiation result when beta-particle emitters come into actual contact with the skin and remain in contact for an appreciable time. These beta-particle emitters can be delivered in the form of fallout dust containing fission products from an atomic detonation. Symptoms of burns produced by this process are not prompt. An itching or burning sensation with skin reddening can occur within a few hours or several days after extended contact with particles; and visible surface lesions can appear two to three weeks later. These should heal with no adverse aftereffects. The presence of burns of either type may or may not be associated with a prompt ionizing radiation exposure.

Nausea and vomiting following radiation exposure are generally indicative of a fairly large dose received over a fairly brief time interval. Evidence for this comes from observations of persons accidentally exposed and of patients undergoing radiation therapy. Since individuals tend to respond differently to common experiences, a precise dose curve cannot be given for radiation-induced nausea and vomiting. Only average values are available. It is generally accepted that doses on the order of about 150 to 175 rem will produce nausea and vomiting in 50 percent of those so exposed, and that 75 to

125 rem is the minimal acute dose likely to produce it in about 10 percent of those so exposed.

Of all the DoD personnel estimated to have participated in or supported the atmospheric testing program over all 17 years, only 31 men are known to have been in a circumstance where radiation exposures could have been received in the range that could cause nausea and vomiting. These were members of an Army and Air Force detachment on Rongerik Atoll and members of a Navy boat pool who were subjected to fallout from Shot BRAVO of Operation CASTLE (1954), when an unexpected wind shift occurred. None of these men exhibited any early signs or symptoms of radiation, such as nausea and vomiting. They were evacuated within 28 hours after arrival of the fallout and received immediate decontamination and care. These men are a part of our NTPR database and are participants in the follow-up to the 1985 NAS mortality study.

With the exception of the two individuals who were aboard the USS BAIROKO during Operation CASTLE (1954), none of the military personnel who received compensation that we know of were in the same group. A table displaying data for ten personnel known to have been compensated follows:

YEAR(S)	OPERATION(S)	LOCATION	GROUP
46/48	CROSSROADS/ SANDSTONE	Pacific	Air Task Group
51	BUSTER-JANGLE	Nevada	Army-Ground
51	BUSTER-JANGLE	Nevada	Air Sampler
54	CASTLE	Pacific	USS BAIROKO
54	CASTLE	Pacific	USS BAIROKO
54	CASTLE	Pacific	Flight Crew
56	REDWING	Pacific	USS GEORGE EASTMAN
57	PLUMBBOB (SMOKY)	Nevada	Task Force WARRIOR
57	PLUMBBOB (SMOKY)	Nevada	82d Abn Div
62	DOMINIC I	Pacific	Army Task Group

It appears that those who were compensated were not the designated film badge wearers for larger groups of soldiers.

In Nevada, during Exercises DESERT ROCK I, II and III (BUSTER JANGLE, 1951) and DESERT ROCK VII and VIII (PLUMBBOB, 1957), most personnel in the forward areas were issued film badges. With the exception of a few personnel whose badges were lost or damaged, and personnel who remained in the rear areas and were not badged, film badge data for these years is believed to be relatively complete. The procedure of issuing film badges to designated group representatives was followed during portions of Exercises DESERT ROCK IV, V, and VI, which took place during AEC Operations TUMBLER SNAPPER, UPSHOT KNOTHOLE, and TEAPOT (1952, 1953, and 1955).

In the early Pacific tests, only a percentage of ship crews were badged; in some cases film badges were limited to the radiological monitors who accompanied boarding parties. These procedures were dictated by carefully conceived radiological safety programs, and available badges were assigned to those personnel with a probability of significant exposure.

More specifically, during Operation CROSSROADS (1946) it was customary to badge only a percentage of the crew. This varied from 10 percent to 50 percent, depending on ship location and mission. Personnel assigned to small boats and parties that boarded target vessels generally wore film badges, and a radiological safety monitor was present as well. Where shortages existed in available film badges, the monitors wore the film badges for the whole group. Crews of ships involved in patrol, and logistic forces in safe areas well back from ground zero, were usually not badged.

During Pacific Operations SANDSTONE (1948), GREENHOUSE (1951), and IVY (1952), film badges were not as a rule issued by ship or unit, but instead were issued to parties sent into islands and areas close to ground zero to retrieve instrumentation and to perform sampling or monitoring assignments. Those groups not expected to be exposed to significant radiation, such as crews of ships in rear areas and personnel on the base support islands, were generally not issued film badges. During CASTLE (1954), approximately 10 percent of the population were issued film badges. For shipboard personnel the procedure was generally to issue a single badge to a group of individuals; the badge was to represent the exposure received by each cohort member.

Commencing with Operation WIGWAM (1955), most Pacific test participants wore film badges. After this time, total exposures represented by film badges are generally available for each individual for the entire series. These badging techniques improved in later series such as REDWING (1956), HARDTACK I (1958), and DOMINIC I (1962) so that recorded film badge exposure is available for most nuclear test participants for these later Pacific nuclear tests.



### Question 3

**Q** How do you estimate the exposure to neutrons, etc. that do not show up on the film badges and how do you translate these into biological effects on different types of tissue? What is the possibility that leukemia was caused by neutron exposure rather than other types of radiation?

**A** As background for the answer, a comment should be made about the probability of test participants being exposed to neutrons. First, neutron exposure could occur only at the time of detonation (prompt radiation). Contact with fallout (delayed radiation) would not cause exposure to neutrons. Thus, the possibility of exposure to neutrons can be determined with relative accuracy, since individuals' locations were known with more certainty at times of detonations than at other times--and were controlled with utmost rigor. Second, neutrons from a detonation are rapidly attenuated in air. For example, at a distance of two miles from an atmospheric nuclear detonation in Nevada, the neutron dose to a totally unprotected individual would be less than one-rem. Of course, no personnel were ever permitted in such an exposed location. Third, neutrons are severely attenuated by earth--for example, by a factor of six in an open trench, or by a factor of 100 behind three feet of earth. Since all personnel at the Nevada Test Site who were within several miles of a detonation were protected in trenches, any neutron exposures that did occur were not only below one rem, but generally in the low millirem range.

Thus the following four points summarize possible neutron exposures: (1) a relatively small percentage of the atmospheric test participants were exposed to neutrons; (2) it can generally be clearly determined whether or not an individual was so exposed; (3) for those so exposed, their neutron dose can be calculated with good accuracy; and (4) most neutron exposures were quite low (less than a rem--generally much less).

The exceptions are the about 500 troop observers at Shot TESLA of Operation TEAPOT, whose reconstructed neutron dose was 1.4 rem, and fewer than 100 members of aircrews for technical projects for Operations TEAPOT and PLUMBBOB and volunteer observers.

The exposure of these individuals to neutrons can be estimated by using computer-assisted calculational techniques to ascertain the interactions of neutrons with the environment as they move from the point of detonation to the locale of interest. The neutron output of the nuclear device itself can be determined from calculations made by the Department of Energy (DoE) weapons design laboratories. Additionally, for many of the devices tested, these calculations of neutron output can be verified by records of experimental measurements of the neutron fluence at varying distances from the detonation. Given the neutron output, computers are used to model environmental interactions as the neutrons move through the atmosphere and as they are affected by the ground-air interface. This type of neutron "transport" calculation normally employs the Boltzmann transport equation to account for neutron sources absorption, and scattering as functions of time, location, direction, and neutron energy. The result of the calculation is a description of the neutron environment at a point of interest. In the case

of troop participation in atmospheric tests, that point normally used is one meter above a trench, or at the relevant observation point. The neutron exposure, if any, at an open observation point (e.g., News Knob at the Nevada Test Site) could be obtained directly from the neutron environment description. The calculation of neutron exposure inside a trench requires further Monte Carlo computer calculations to transfer an appropriate fraction of the environment above the trench to the interior of the trench. (Monte Carlo programs are mathematical methods which can perform complex geometry calculations for probabilistic processes.) The Monte Carlo calculation involves modeling the trench and neutron source geometry in detail. It yields a description of the neutron exposure in rads (a rad is 100 ergs per gram) as a function of location within the trench.

Biological effects are generally described in terms of Roentgen-equivalent-man, or rem. Although there continues to be scientific debate on the conversion of neutron exposure to a dose equivalent, most health physicists rely on the National Committee on Radiation Protection (NCRP) Report No. 91, "Recommendations on Limits for Exposure to Ionizing Radiation," NCRP 91, 1987, as the authority for the conversion. This report gives "Quality Factors" for converting neutron exposures of a given energy to a dose equivalent. (Dose equivalent in rem equals Quality Factor times exposure in rads.) Quality Factors vary with neutron energies; however, an average value of 10 is presently used in most health physics calculations. A rem of neutron radiation is equivalent to a rem of gamma radiation and has the same probability of causing any biological effect.

Although the possibility exists that cases of leukemia among the participants might have been caused by neutron exposure, the much greater collective dose (man-rem, including the Quality Factor consideration) from gamma than from neutron radiation indicates that the latter did not significantly increase the rate of leukemia incidence.

Question 3 also implied a query as to estimation methods for exposures other than neutron, i.e., beta and alpha.

External exposure to beta radiation would come from fallout, not from prompt radiation at detonation. As beta radiation is stopped by a few millimeters of body tissue and not deeply penetrating, it would not be a factor in causing leukemia.

The final potential source of exposure is alpha-emitting particles, also found in fallout. Film badges are not intended to, and do not, measure external radiation doses due to alpha-emitting particles contained in the fallout field. At the test sites, alpha counters were used to assess the hazard in areas where alpha contamination was expected to be significant.

Since alpha particles can be stopped by a few inches of air, or a sheet of paper, or skin, the primary concern is whether or not the test participants may have received internal doses as a result of inhalation or ingestion of radioactive fallout. There are methods that may be used today to evaluate past exposure from internally deposited radionuclides, which may emit alpha, beta, and gamma radiation.

The metabolism of radioactive isotopes has been extensively studied for many years. A great deal of information is known about their retention in the body, their translocation from one organ to another, and their elimination from the body. Models are available which enable calculation of an initial intake based on the measurement of the quantity currently in the body or eliminated from the body over a specified period of time. By ascertaining the current level and applying appropriate models which take into account the biological elimination and the physical decay of the selected isotopes, the approximate initial uptake can be calculated, and the resultant dose over time can be estimated.

Very sensitive methods are available for measuring radioactive isotopes contained within the body or eliminated through urine. These methods include whole-body gamma ray measurements (whole-body count), measurement of possible chest content of low-energy X-ray emitters, and radiochemical analysis of urine samples.

Measurements utilizing the above methods had been performed on 16 men who took part in Shot SMOKY (1957). No activity in excess of typical background levels found in men not exposed to weapons tests was detected. The exams were performed by the Center for Human Radiobiology at Argonne National Laboratory in Chicago, and the results indicate it is unlikely that the men experienced any significant internal contamination. The level of plutonium-239 in their bodies was less than the sensitivity of the detection capability of 4.5 femtocuries. (A femtocurie is  $10^{-15}$  curie; a permissible lung burden of plutonium under U.S. standards is 16 nanocuries ( $16 \times 10^{-9}$  curies) or 16,000,000 femtocuries.) Levels of strontium-90 and cesium-137 (two of the major fallout radioactive isotopes) in the men were well within typical values found in the general population.

In addition to these measurements, an extensive autopsy was performed on one of the Shot SMOKY participants who died. This individual was diagnosed as having acute myelocytic leukemia and was awarded compensation by the VA. Analysis of pathological specimens did not reveal radioactive isotopes in excess of the general background level found in non-test participants.

*In summary, the probability that fatal cancers among test participants are caused by exposure to radiation of any type--neutron or otherwise--from the tests appears to be very low, based upon published cause-effect relationships. Indeed, the generally accepted estimate, based on BEIR V (8/10,000), is that one rem of radiation to each of 10,000 individuals would, on average, result in eight fatal cases of cancer in that group over the lifetime of the individuals, whereas about 1,600 fatal cancers would be expected from other causes. Based upon the research and dose reconstruction performed throughout the NTPR program, the average dose of the approximately 205,000 test participants is about 0.6 rem, or about 40% less than the one rem used in the above calculation.*

#### Question 4

**Q** What is the total number of military and civilian personnel involved in close-range detonation, post-detonation cleanup, and exposure to fallout since 1946?

**A** One of the primary objectives of the DoD Nuclear Test Personnel Review is to reconstruct rosters of DoD nuclear test participants, to recover radiation exposure data, and to develop details of participation (location at detonation time, protection afforded, post-shot movements with respect to fallout, etc.). DOE is responsible for civilian personnel.

To date we have identified approximately 210,000 DoD-affiliated personnel who supported or participated in the 20 U.S. atmospheric test series conducted from 1945 to 1962, as scientists, technicians, maneuver and training troops, and as administrative, logistical, and operational support personnel. This number includes uniformed military personnel, civil service employees of DoD and its components, and civilian employees of DoD contractors. Of the 210,000 participants, approximately 16,000 participated in multiple operations. In 1988, our program was expanded to include participants in the occupation of Hiroshima and Nagasaki. We have identified approximately 195,000 participants in that population.

The personnel who were closest to ground zero at the times of detonation were the approximate 42 participants in the Officer Volunteer program at the Nevada Test Site--already discussed in the answer to question 1. Five of these personnel were located at ground zero beneath a high-altitude test in 1957. This was Shot JOHN of Operation PLUMBBOB (1957), a 2 KT device detonated as an air burst at 20,000 feet. Radiation doses to these five personnel were too low to measure and are estimated to be less than one millirem. Some 37 other Officer Volunteers participated in trenches during four shots during the 1953 and 1955 test series. Distances from ground zero ranged from 2000 to 2600 yards for devices yielding from 23 to 42 KT. Measured gamma doses to the group (including both prompt and residual radiation) ranged from 0.3 to 16.3 rem. Calculated neutron doses ranged from 0.007 to 28 rem.

At the Nevada Test Site, the next closest personnel were approximately 26,000 observers, troops, and others who occupied trenches, bunkers, or armored vehicles from 2500 to 5500 yards from ground zero for detonation of devices ranging from 3 to 74 kilotons. These exercises were conducted during the 1953, 1955, and 1957 test series. Radiation exposures to this group were generally quite low.

A much larger number of personnel observed the Nevada shots at greater distances, ranging up to about 18 miles, during the entire test period there from 1951 through 1962.

At the oceanic test sites, weapon yields were generally higher and safe distances were significantly greater. A smaller number of personnel is estimated to have been in the close-range detonation category, including selected island observers and Navy medical personnel involved in retrieving test animals.

An accurate estimate of how many of the 210,000 DoD participants were exposed to fallout during atmospheric testing is unavailable, but could be as great as 150,000. Personnel entering fallout fields generally consisted of maneuver troops, observers witnessing weapons effects displays, and scientists recovering experiments and instrumentation. Some of these personnel types only entered neutron-induced radiation fields, which often had radiation levels similar to fallout fields.

Post-shot entry into induced and fallout fields during atmospheric testing was very tightly controlled, and radiation exclusion areas were routinely established. An area where the measured radiation intensity exceeded 100 millirem per hour was designated a full radiation exclusion area, and entry therein required full protective clothing and the presence of a trained monitor. Areas where the intensity exceeded 10 millirem per hour were designated limited radiation exclusion areas. Entry also required the presence of a trained monitor, and protective clothing was required depending on mission and stay times. These areas were established by reentry teams who made measurements commencing about one hour after detonation, when all close-in fallout had settled. Because of the rapid decay of early fallout, these exclusion areas having dose levels of 10 millirem per hour or greater were reduced in size to a small fraction of their original area with the passage of even one day.

At the Nevada Test Site, areas where the dose level exceeded 10 millirem per hour were cordoned off. Signs were posted designating the controlled areas. Also, during the first 24 hours after detonation access to areas in the vicinity of ground zero area was stringently controlled by guards to limit the possibility for accidental exposure.

At oceanic test sites, radiation exclusion areas were also marked, and entry required the accompaniment of monitors. An additional measure of control was provided by the fact that all personnel were forced to rely on centrally controlled sea and air transportation to approach contaminated areas.

During Desert Rock Exercises from 1953 through 1957, the Commander of Camp Desert Rock assumed responsibility for radiological safety of all Desert Rock personnel. The procedures for marking contaminated areas and for having radiological monitors accompany maneuver troops and observer groups were very similar to those employed by the Atomic Energy Commission.

Throughout all 17 years of testing in Nevada and the Pacific the extensive radiological safety efforts were quite successful, for 99 percent of all known recorded exposures are within established allowable exposure limits.

There have been two major post-detonation cleanup operations: The first at Bikini Atoll in 1969; and the second the cleanup of Enewetak Atoll, from 1977 to 1980.

*The cleanup of Bikini Atoll in 1969 was a relatively short operation of small scope. About 100 military, Trust Territory, AEC, and contractor personnel were involved.*

The Enewetak cleanup was a joint operation by DoD, DOE, and the Department of the Interior (DoI). DoD was responsible for base camp maintenance and for actual cleanup operations; DOE was responsible for radiological measurements and final certification; and DoI was responsible for rehabilitation and resettlement of the islands.

The typical number of personnel on-atoll at any one time was about 970, of which some 650 were military and the remainder were civilians.

In all, over 4,000 U.S. servicemen served on-atoll in the Enewetak cleanup. Radiation exposures during the Enewetak cleanup were extremely low.

## Question 5

**Q** Given the uncertainties for determining radiation doses obtained from nuclear workers' exposure records, how accurate are exposure (dose) estimates in radiation studies in general, and how accurate were they for the SMOKY test soldiers? How are film badge data recorded; what errors are inherent in personnel dosimetry?

**A** Some veterans have questioned the accuracy and reliability of the film badges used during atmospheric nuclear testing between 1945 and 1962. To provide an independent assessment of the issue, DNA commissioned the National Academy of Sciences (NAS) on September 28, 1987 to organize a Committee on Film Badge Dosimetry in Atmospheric Nuclear Tests. Committee members included recognized experts in photographic film processing, development, and interpretation; film badge dosimetry and applications; statistical treatment of uncertainties; radiation characteristics of nuclear weapons; and legal implications of study results. One committee member had continuous involvement with nuclear testing for many years.

The committee's mandate was to:

- Evaluate the reliability of film badge results from atmospheric nuclear testing;
- Recommend procedures for deriving the best dose estimates from these badges; and
- Quantify the uncertainty of these estimates.

After an 18 month investigation, the committee found that:

- Film badges were adequate and reliable from the beginning of testing, particularly for measurement of exposures above 0.1 Roentgen;
- The reliability and precision generally improved throughout the period of testing; and
- While uncertainty increases with lower exposures (generally accepted as below about 20 rem), the overall uncertainty was small enough to make the data useful for consideration of potential biological effects in individual participants.

Moreover, the committee quantified the uncertainties in film badge readings for specific atmospheric test operations and dose ranges. Except for very low film badges readings, upper-bound doses were never as much as twice the film badge readings.

## Question 6

**Q** What range of exposures were recorded at all weapons tests? What fallout levels were reached in Utah; other parts of the U.S.? How much fallout was caused by non-U.S. tests (i.e., Russian, French)?

**A** The range varies from 0 to 52 rem.

To focus on the higher exposures, a thorough search of all records has been conducted for DoD personnel with cumulative exposures from atmospheric testing in excess of 25 rem, the current Federal standard for planned exposures under emergency conditions. A total of 36 individuals have been identified: 28 received doses ranging from a reconstructed dose of 32 rem to a recorded dose of 52 rem from fallout incident to an unexpected yield and wind shift at the 1954 detonation of Shot BRAVO, Operation CASTLE, at Bikini (25 Air Force and 3 Army weather station personnel on Rongerik Atoll). Six others were Air Force cloud samplers who received cumulative doses ranging from 25 to 28 rem during periods of from two to five years. The last two--a civilian scientist and an Air Force scientist--received doses of 35 and 42 rem respectively over a number of years. Four of these individuals are known to have died from causes not associated with radiation. The remainder are not known to have any radiation-induced illness, and all were invited to participate in a medical examination program. Examinations were administered to 12 individuals who desired to participate in the over-25-rem medical examination program.

The tables below summarize the external doses received by DoD atmospheric nuclear test participants as of January 17, 1994.

The numbers in the over five to ten rem column in the following tables represent those personnel who received a total dose (either recorded, reconstructed, or both) in excess of five rem per series. An individual who received over five rem as a result of his participation in two series conducted during a consecutive 12-month period, i.e., IVY (conducted November 1 through December 31, 1952) and UPSHOT-KNOTHOLE (conducted March 17 through June 20, 1953), would not have his total dose of over five rem reflected in the column. It should be noted that Federal guidelines limit occupational radiation exposure to 5.0 rem per calendar year instead of twelve-consecutive months (Code of Federal Regulations, Title 10, Part 20).

Additionally, when recorded dosimetry data was originally found early in the program, the only date information generally available was series year. However, over the years more definitive date information has been found. This information has impacted the ver-five rem program as illustrated by the following example: An individual may have received a dose of three rem during Operation TUMBLER-SNAPPER (conducted April 1 through June 20, 1952) and three rem during Operation UPSHOT-KNOTHOLE (conducted March 17 through June 20, 1953). Since these two series were conducted within twelve-consecutive months of each other and since the only dates associated with



his doses were the series years of 1952 and 1953, the individual would have been considered an over-5 rem participant. However, the availability of day and month information may have indicated that he received his TUMBLER-SNAPPER dose of three rem during April 1952 and his UPSHOT-KNOTHOLE dose of three rem during May 1953. Therefore, he would no longer be an over-5 rem participant.

Finally, reconstructed dose data has been revised over the years to accommodate the findings of continuing research efforts. The application of these revised reconstructions has resulted in the identification of a small number of new over-5 rem participants and the deletion of others from this category.

In summary, the number of over-five rem participants is a fluid one as the refinement of dosimetry information remains a NTPR program objective.

The remaining answers fall outside the purview of the Defense Nuclear Agency and should be addressed separately by the Department of Energy (DOE).

# Summary of external doses for DoD atmospheric nuclear test participants as of 17 January 1994.\*

## Badged Doses Only

Operation		Dose (rem)							Totals
		0	>0-0.5	>0.5-1.0	>1.0-3.0	>3.0-5.0	>5.0-10.0	>10.0	
TRINITY		232	152	62	107	34	14	2	603
CROSSROADS		1267	1038	114	43	5	0	0	2467
SANDSTONE		159	126	7	10	1	1	0	304
RANGER		7	88	5	3	3	1	0	107
GREENHOUSE		499	708	382	608	80	34	6	2317
BUSTER-JANGLE		2448	1894	134	284	41	5	0	4806
TUMBLER-SNAPPER		287	911	129	233	50	11	1	1622
IVY		94	301	30	61	4	6	3	499
UPSHOT-KNOTHOLE		584	846	201	347	236	59	9	2282
CASTLE		421	2383	1996	2319	730	228	36	8113
TEAPOT		450	1213	140	264	160	14	10	2251
WIGWAM		6030	367	1	2	0	0	0	6400
REDWING		699	2902	2670	3166	1467	129	11	11044
PLUMBBOB		2668	5791	892	778	77	35	2	10243
HARDTACK I		1413	3998	3355	3833	194	74	8	12875
ARGUS		0	0	0	0	0	0	0	0
HARDTACK II		969	505	81	58	9	5	2	1629
DOMINIC I		8500	8855	200	343	17	9	9	17933
DOMINIC II		2764	594	127	184	7	1	0	3677
Total		29491	32672	10526	12643	3115	626	99	** 89172

\* The figures in each dose column show the number of DoD participants at a given U.S. atmospheric nuclear test series who received an external dose in the indicated range. For individuals on this table, the doses were measured by one or more film badges.

\*\* Because some personnel participated in more than one test series, the total includes some double counting.

# Summary of external doses for DoD atmospheric nuclear test participants as of 17 January 1994.\*

## Reconstructed Doses Only

Operation		Dose (rem)							Totals
		> 0-0.5	> 0.5-1.0	> 1.0-3.0	> 3.0-5.0	> 5.0-10.0	> 10.0		
TRINITY	22	2	0	1	33	2	0	60	
CROSSROADS	7835	22896	6717	2715	1	0	2	40166	
SANDSTONE	231	7763	2	1	0	0	0	7997	
RANGER	18	16	0	0	0	0	0	34	
GREENHOUSE	679	412	268	1250	1143	4	0	3756	
BUSTER-JANGLE	107	2206	429	304	255	0	0	3301	
TUMBLER-SNAPPER	127	6985	457	25	0	0	0	7594	
IVY	11	8071	1	0	0	0	0	8083	
UPSHOT-KNOTHOLE	153	4248	1287	6191	2734	47	7	14667	
CASTLE	318	2956	248	1062	4	23	3	4614	
TEAPOT	496	2428	2535	922	550	51	1	6983	
WIGWAM	261	99	0	0	0	0	0	360	
REDWING	431	441	53	44	23	0	0	992	
PLUMBBOB	213	129	1098	134	0	1	3	1578	
HARDTACK I	1060	121	155	285	60	0	0	1681	
ARGUS	4525	0	0	0	0	0	0	4525	
HARDTACK II	3	2	0	0	0	0	0	5	
DOMINIC I	2822	1267	36	18	0	0	0	4143	
DOMINIC II	29	0	0	0	0	0	0	29	
Total	19341	60042	13286	12952	4803	128	16	110568	

\* The figures in each dose column show the number of DoD participants at a given U.S. atmospheric nuclear test series who received an external dose in the indicated range. For individuals on this table, the doses were measured by one or more reconstructed doses.

\*\* Because some personnel participated in more than one test series, the total includes some double counting.

# Summary of external doses for DoD atmospheric nuclear test participants as of 17 January 1994.\*

## Badged and Reconstructed Doses Only

Operation	Dose (rem)						
	0	>0-0.5	>0.5-1.0	>1.0-3.0	>3.0-5.0	>5.0-10.0	>10.0
TRINITY	145	0	3	4	6	2	1
CROSSROADS	148	1264	846	1305	5	1	0
SANDSTONE	8	3346	48	32	5	1	0
RANGER	0	0	0	0	0	0	0
GREENHOUSE	46	100	233	731	402	135	3
BUSTER-JANGLE	10	322	32	33	40	0	0
TUMBLER-SNAPPER	0	164	18	4	0	0	0
IVY	0	1357	46	63	5	0	11
UPSHOT-KNOTHOLE	2	13	9	64	16	8	1
CASTLE	2	331	223	424	109	135	7
TEAPOT	5	18	14	14	5	1	0
WIGWAM	26	28	0	0	0	0	0
REDWING	0	382	389	563	134	33	3
PLUMBBOB	51	837	141	78	7	3	0
HARDTACK I	8	466	731	264	16	1	0
ARGUS	0	0	0	0	0	0	0
HARDTACK II	0	5	0	0	0	0	0
DOMINIC I	71	248	3	1	0	0	0
DOMINIC II	1	1	0	0	0	0	0
Total	523	8882	2736	3580	750	320	26
							** 16817

\* The figures in each dose column show the number of DoD participants at a given U.S. atmospheric nuclear test series who received an external dose in the indicated range. For individuals on this table, the doses were measured by one or more film badges and one or more reconstructed doses.

\*\* Because some personnel participated in more than one test series, the total includes some double counting.

## Question 7

**Q** Why wasn't a medical follow-up immediately started on those exposed to nuclear weapons testing and fallout instead of waiting until the late 1970's?

**A** Prior to 1977, there was no apparent reason for conducting a medical follow-up program on test participants. First, the great majority of all exposures--probably upward of 99 percent--had been well within the limits that medical science thought were safe (and conservatively so). Second, some DoD groups that had received higher exposures had been followed up, and no adverse health effects had been discovered. Third, no pattern of test-related illnesses had been noted in the periodic medical examinations that are routinely conducted on all servicemen; and finally, there was no information from the VA, the Centers for Disease Control (CDC), or other national sources outside DoD to indicate the possibility of a problem.

It is important to note that of the 210,000 test participants, about 33,000 are expected to die of leukemia and other cancers independent of any radiation received during test participation. Prior to 1977, there were no indications that disease incidence, deaths, or VA claims in the cases of test participants exceeded these national norms.

A small number, but larger than expected number of leukemias originally prompted the NTPR Program in 1977. By 1978, eight leukemia cases had emerged (where only three or four were expected) among the approximately 3200 DoD personnel who, in 1957, were at or near the Nevada Test Site on the day of Shot SMOKY, Operation PLUMBBOB. The CDC published the results of an epidemiological study of this group in the Journal of the American Medical Association on August 5, 1983. The conclusions were that participant death due to cancer, as well as total number of cases of cancer, were slightly less than the statistical norm, except for the larger-than-expected number of leukemia cases. CDC attributed this increase to chance, to factors other than radiation, or to some combination of risk factors, possibly including radiation. An additional finding was that the total number of deaths from all causes was essentially as expected from natural causes.

Concurrently with CDC, the Defense Nuclear Agency (DNA) engaged the National Academy of Science (NAS) to study the health status of more than 46,000 test personnel. The NAS selected participants at PLUMBBOB and four other test operations: REDWING (1956), CASTLE (1954), UPSHOT-KNOTHOLE (1953), and GREENHOUSE (1951). The Academy, an independent, Congressionally chartered organization, utilizes leading national experts in their respective fields to conduct such reviews. Jointly funded by DNA and the Department of Energy (DOE), this study, entitled "Mortality of Nuclear Weapons Test Participants," encompassed nearly one-fourth of all veterans involved in atmospheric nuclear tests.

The study report, released in June 1985, concluded that "the total body of evidence we have reviewed cannot convincingly either affirm or deny that the higher than statistically

expected incidence of leukemia among SMOKY [an individual test shot in the PLUMBBOB series] participants (or of prostate cancer among REDWING participants) is the result radiation exposure incident to the test." The report elaborated further by stating, "However, when the data from all the tests are considered, there is no consistent or statistically significant evidence for an increase in leukemia or other malignant disease in nuclear test participants." One of the co-authors of the report stressed that there were limitations in the study design that might affect the scope of conclusions and recommended future reanalysis of the mortality rates among the same participants. The Office of Technology Assessment made a similar recommendation to Congress

On September 8, 1992, DNA awarded a contract to NAS to conduct a follow-up mortality study. The follow-on study is expected to overcome these limitations and will again search for significant increases in incidence of cancers among participants at these test series. Among the reasons for performing the follow-on study is the need to address the following key issues:

- The first study compared cancer mortality data of test participants to like incidence data for the general U.S. population. The follow-on study will use comparable Service personnel who were not participants at the time of testing as the comparison population. It is known that personnel selected for military service were healthier than the general population.
- A 1989 comparison of purified participant data to the 1981 data used in the original study revealed that there were some names which could not be matched to those in the study population and others which had been excluded. The follow-on study will concentrate on a more accurate and thorough review of military records, participant names, and Service numbers to determine the correct assignment of personnel from the current data base to the test participant group.
- Since 1981, the cutoff year for collecting data for the first study, about 10 years of additional mortality data has accumulated for the participant group. In studies of Japanese survivors from Hiroshima/Nagasaki, leukemia is the earliest appearing cancer following radiation exposure. For other cancer types, it may take 30 years or more for them to appear under similar exposure conditions. It is important to see if there are excess incidences of cancers emerging among the test participants, especially leukemias, which should have become completely apparent in the participant groups if they are related to radiation exposure.
- Dose records used in the first study did not fully reflect all periods in which some participants were exposed to radiation at these test series. Also, monitoring devices worn at that time by participants registered most, but not all of their dose from external radiation exposure. Since then, reconstructed radiation doses have been calculated from historical data. These reconstructed doses account for periods when participants were exposed, but monitoring devices were not worn or were lost during the test series. Dose reconstructions have also been

performed to account for unregistered external doses and for doses from inhaled or ingested particles of fallout. These calculated doses, which have already been added to the participants' recorded doses, will be used in the follow-on study.

The results of the follow-on study expected to be completed in fall 1997, should provide a current assessment of mortality due to cancer occurrence in U.S. atmospheric nuclear test participants. Comparison of results from the two studies will indicate the influence of the key issues on the new study's conclusions.

NAS also convened a panel in May 1981 to investigate the incidence of multiple myeloma among the occupation forces of Hiroshima and Nagasaki. DNA and veterans groups provided the Academy with the names of all known participants who reportedly had multiple myeloma. NAS concluded that the reported incidence of nine verified cases of multiple myeloma among U.S. veterans of the occupation forces stationed at or near Hiroshima and Nagasaki is less than the incidence in the general population. The expected incidence in a group of this size would be 18.

DNA and the VA are supporting an additional NAS study, initiated in 1988. The study is examining the mortality of the some 42,000 participants at Operation CROSSROADS, as well as that of a control group of a like number of unexposed personnel serving at the same time and in similar duties. The use of a control group will ensure that the mortality of CROSSROADS participants is compared to that of personnel whose basic activities and initial level of health were similar. The study should be completed in early 1996.

As a result of Public Law 97-72, "Veterans' Health Care, Training and Small Business Loan Act of 1981," the VA provides medical examinations, hospital and nursing home care and limited outpatient services to all eligible veterans who participated in U.S. atmospheric nuclear testing or the occupation of Hiroshima and Nagasaki, Japan.

## Question 8

- Q In terms of compensation, what will be done to help veterans facilitate their claims?
- A Claims, benefits and compensation are properly the responsibility of the VA.

However, the following data discusses DoD's role in providing all possible assistance to individual veterans, and to the VA, in facilitating the claims process.

As indicated in answers to previous questions, the Nuclear Test Personnel Review (NTPR) Program, established by the Department of Defense in 1978, has developed an extensive support system to assist the veterans of atmospheric nuclear tests in verifying their participation and determining their radiation exposure. The table at the end summarizes NTPR resources.

Through the NTPR Program, veterans learn the details of their individual participation and their radiation doses, obtain documentation about the tests and their unit's role, and obtain information regarding the availability of health care and other assistance provided by the VA.

DNA directs the NTPR Program on a high-priority basis. Dedicated and knowledgeable uniformed and civilian personnel from the Army, Navy, Marine Corps, and Air Force initially researched the extensive archival records to provide the data about the thousands of units that participated in nuclear tests conducted from 1945 until the treaty banning atmospheric nuclear testing took effect in 1963. More recently, the resources committed to assist in this important effort have been consolidated at DNA to facilitate greater efficiency. To make all these items of information personally available to the veterans and other interested persons, DNA has established a reading room which is open to the public.

Through extensive public outreach programs in the press and on television and radio, as well as with the many veterans groups, DNA continues to encourage "atomic veterans" to contact DNA to share and examine the available information about their participation. Such contact enables each veteran to draw on DNA's wealth of information to apply to his individual case; it also allows the veteran to contribute any information about his participation that may be of help to others in his unit by augmenting the records that DNA has compiled.

Public Law 97-72, the "Veterans' Health Care and Small Business Loan Act of 1981," authorized the VA to provide hospital and nursing home care and limited outpatient services to "veterans who were exposed while serving on active duty to ionizing radiation from the detonation of a nuclear device in connection with such veteran's participation in the test of such a device, or with the American occupation of Hiroshima and Nagasaki during the period beginning September 11, 1945 and ending July 1, 1946." This law provides for medical care related to radiogenic diseases, but does not authorize care for



conditions that are found by the VA to have resulted from other than the exposure to ionizing radiation. DNA assists the VA by verifying an individual's participation.

Public Laws 98-542 and 100-321 provide for VA determination of service connection and benefits for specified cancers. More specifically, PL 98-542, "Veteran's Dioxin and Radiation Exposure Compensation Standards Act," enacted October 24, 1984, defines rules for adjudicating VA claims and establishes a panel of experts for addressing scientific issues. PL 100-321, "Radiation Exposed Veterans Compensation Act of 1988," enacted May 20, 1988 (as amended by Public Law 102-578, "Veterans' Radiation Exposure Amendments of 1992"), provides a presumption of service connection for veterans (and survivors of such veterans) who participated in atmospheric or underwater nuclear tests as part of the United States nuclear weapons testing program or in the American occupation of Hiroshima and Nagasaki, Japan, and who suffer from certain diseases that may be attributable to exposure to ionizing radiation. Public Law 102-86, "Veterans' Benefits Program Improvement Act of 1991," enacted August 14, 1991, amended Public Law 100-321 to include eligible reservists and National Guard members. DNA assists the VA by providing participation and any associated radiation exposure information. Additional information about these benefits is available at local VA facilities. Veterans can receive free assistance in submitting claims by contacting one of the veterans' service organizations.

The Radiation Exposure Compensation Act (Public Law 101-426, Oct 90), as amended by the 1991 DoD Authorization Act (Public Law 101-510, Nov 90), established the Radiation Exposure Compensation Trust Fund. Benefits are available for verified on-site participants in U.S. atmospheric nuclear weapons tests if the individual has one of the diseases listed in the Act. The Trust Fund established by this law is being administered by the Department of Justice (DOJ).

**NTPR Government and contractor person years from 1978 through 30 September 1993.**

	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	TOTAL
DNA*	6	10	7	6	6	4	4	3	3	2	4	4	4	5	5	5	77
DoD**	74	160	197	201	186	140	60	54	60	68	73	75	73	64	62	64	1,610

\*In-house

\*\*In-house and contractors combined

**NTPR funding in millions of dollars from 1978 through 30 September 1993.**

	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	TOTAL
DNA Contract Costs	1.91	4.75	6.91	6.66	6.31	3.03	1.60	1.94	1.75	2.36	2.75	3.42	3.70	4.15	3.88	4.50	59.62
Other DoD Contract Costs	1.59	1.70	2.31	1.80	1.59	1.55	1.53	1.03	0.90	1.12	0.39	0.41	0.33	0	0	0	16.25
DoD Total Manpower Costs	0.39	1.15	1.46	1.52	1.63	1.26	0.79	0.62	0.59	0.32	0.19	0.19	0.19	0.30	0.30	0.30	11.20
DoD Total Contract & Manpower Costs	3.89	7.60	10.68	9.98	9.53	5.84	3.92	3.59	3.24	3.80	3.33	4.02	4.22	4.45	4.18	4.80	87.07

## Question 9

**Q** Will veterans be able to obtain information currently denied them which can prove they were present during a nuclear testing exercise, what dose they may have received, and other materials which could help ascertain the veterans' degree of exposure?

**A** At the outset, it is essential to clarify terms. No information whatsoever is being "denied" veterans by DoD, in the sense that this expression refers to available information being withheld, or there being a reluctance to spend time and effort to dig information out of the files. As the answers to previous questions show, DoD is doing everything possible to retrieve and reconstruct records on a high priority basis.

Three points which bear on this issue deserve mention:

Every test participant who contacts our program is provided information regarding their exposure potential. However, the extent to which we can provide copies of source documents is constrained by their classification status. Information regarding source terms and radiochemistry that are used in our reconstruction methodology remain classified because they reveal nuclear weapons design information. However, where applicable, this information is used in determining the veteran's radiation dose.

Hundreds of thousands of publications containing information pertinent to U.S. atmospheric nuclear weapons tests have been declassified and are available at the Coordination and Information Center (CIC) of the U.S. Department of Energy, Las Vegas, Nevada. The CIC is the government's major public repository of unclassified materials on U.S. atmospheric nuclear testing, available to veteran participants.

Historical reports concerning U.S. atmospheric nuclear testing are also available to the public through the National Technical Information Service (NTIS). Copies of these publications may be purchased through NTIS. Over 700 facilities nationwide, most of them libraries, have received copies of the historical volumes.

Second, there is a serious problem with availability of some personnel records. When individuals leave the Service, in many cases the parent service turns the individual service records and medical records over to the General Services Administration (GSA) for storage. In 1973, a major fire in the GSA storage buildings in St. Louis destroyed the records of some 17 million former servicemen--a great deal of them test participants. This loss of data has represented the same handicap to NTPR researchers that it has to the individual veterans and the VA.

However, surviving personnel service and medical records as well as unit morning reports and officer flight logs are available through the National Personnel Records Center (NPRC) in St. Louis, Missouri. Veterans may request their individual records from NPRC.

Third, in some cases the Privacy Act and other U.S. statutes have denied, restricted, or delayed access to needed records.

DNA provides all nuclear test veterans with a responsive, helpful program of historical research, dose determination, and individual support to ensure that each veteran fully understands his or her involvement in the U.S. atmospheric nuclear test program. Personnel who contact our program are provided with a detailed letter and package of information concerning our program and their role in U.S. atmospheric nuclear testing. Attached to the letters of verified participants are their radiation exposure data, fact sheets, a VA Radiation Information sheet, copies of Public Laws, a facilities list and various other enclosures. Personnel whose participation cannot be verified are provided with a detailed letter summarizing our research efforts and generally containing pertinent enclosures, i.e., service record excerpts, deck log abstracts, morning report excerpts, etc. Any test participant who can provide copies of personal records is invited to send them to DNA if it appears that his or her information is based on incomplete records.

## Question 10

**Q** Are there other areas of the country, besides southern Utah, northwestern Arizona, and areas of southern Nevada adjacent to the Nevada Test Site, that received high concentrations of nuclear fallout during atmospheric testing?

- A**
- No, safety policies associated with test detonations were designed to ensure that high concentrations of fallout did not extend far beyond the test site or to major population centers.
  - Detonations were postponed if there were unfavorable wind patterns and directions, or if precipitation was forecast within several hundred miles downwind from the test site.
  - Beginning with the first NTS test series, RANGER in 1951, the Public Health Service monitored fallout levels across the country, and would find trace amounts of radioactivity as far away as New England.
  - Shot SMOKY in 1957, one of the highest-yield tests in Nevada, had fallout that was detected northeastward as far as the northern plains states and Canada, but radiation levels greater than 1 mR/hr (adjusted to 12 hours post-shot, prior to fallout arrival at distant locations) were measured only as far as Wyoming.
  - Shot SIMON in 1953, also one of the highest-yield tests in Nevada, resulted in the most fallout outside of the mountain states when a heavy thunderstorm in New York State brought radioactivity to earth around Albany that was measured at the mR/hr level.
  - External radiation doses resulting from even the unusual levels of distant fallout indicated above were less than the annual background dose.
  - A finding of potentially significant fetal and infant thyroid doses from radioiodines in low-level fallout led to nationwide milk monitoring by the Public Health Service after 1953.



TITLE	SOURCE	SYNOPSIS
Secret Tests Spread Radiation in NM, UT, and TN	16 DEC 93 GAZETTE TELEGRAPH, (AP)	Senator Glenn releases GAO report of 1 dozen radiation tests (1948-52).
Many Wonder if Radiation is Root of Ills	11 JAN 94 USA TODAY, Linda Kanamine	Detroit infants were injected with I-131 in 1954. Pu was injected into 18 adults. Pregnant women were given radioactive Iron. Students were fed radioactive cereal & milk. Prisoners testes were irradiated. 200 radiation experiments were conducted in 33 VA hospitals.
A 'Lone Voice' in Nuclear Debate	11 JAN 94 USA Today, Paul Hoversten	Rep. Ed Markey released 'AMERICAN NUCLEAR GUINEA PIGS' in 1986. Documents 31 U.S. Govt. radiation experiments on 695 Americans from 1940s-70s.
Energy Coming Clean as O'Leary Discloses Secrets	Denver Post, Keith Schneider, New York Times	Secretary O'Leary struggles to manage flood of negative revelations about DOE radiation experiments.
White House Forms Panel to Investigate Cold War Radiation Tests on Humans	04 JAN 94 Wall Street Journal, Timothy Noan	7 federal agencies on task force to investigate radiation experiments. DOE, HHS, DOJ, DOD, DVA, OMB, & NASA.
Soviet Atom Test Used Thousands as Guinea Pigs, Archives Show	07 NOV 93 New York Times, Marlise Simons	All nuclear powers conducted atomic weapon experiments on their soldiers. Western nations attempted to use existing atomic safety standards.
O'Leary Urges Compensation for Radiation Guinea Pigs	29 DEC 93 Gazette Telegraph, (AP)	Sec. O'Leary says that people wrongfully exposed to radiation in federal funded experiments deserve compensation.
Scientists Study "Cold War" Fallout	24 Dec 93 Science Vol. 262 by Richard Stone	GAO reported that Americans were deliberately exposed to radiation without their consent or knowledge in a dozen experiments conducted between 1948 and 1952 to explore the feasibility of radiological weapons.

TITLE	SOURCE	SYNOPSIS
U.S. Hid 204 Atomic Tests from Public	Gannett News Service [no date]	The DOE disclosed that U.S. had conducted 204 unannounced atomic tests. The revised total is now 1,051 tests vice 847 tests. The DoE also released info on yield of 48 tests conducted in Pacific during the 1950s. Since 1945, 89 metric tons of weapons grade plutonium and 13 tons reactor grade plutonium produced by U.S. One third remains at DOE facilities. Also 24 million pounds of mercury is believed to have been used at the Y-12 weapons plant at Oak Ridge.
VA Announces Steps to Aid Gulf Veterans	Washington Post, Wednesday, Nov 17, 1993 by Bill McAllister - Washington Post Staff Writer	Federal government moved yesterday to meet needs of thousands of Persian Gulf War veterans coming down with mysterious illnesses since return home from war against Iraq. VA will review applications for compensation "on case by case basis".
U.S. Spread Radioactive Fallout In Secret Cold War Weapons Tests	Source not listed nor dtd by Keith Schneider	The United States deliberately released large amounts of radiation into the environment in the 1940's and early 1950's as part of secret program aimed at developing a weapon that would kill enemy soldiers with radioactive fallout. Info obtained from Congressional study made public yesterday.
America's Nuclear Secrets	From NEWSWEEK Issue dtd Dec 27, 1993	In the 1940s and '50s, researchers subjected hundreds of ill-informed people to doses of nuclear radiation to study the effect on human beings. Later on, in two experiments on the West Coast, 131 prison inmates, many of them black, had their testicles irradiated.



TITLE	SOURCE	SYNOPSIS
Government Stonewalled Radiation Complaints Local Experiments	The Boston Globe dtd Jan 9 1994 Sunday City Edition	<p>Article summarizes the events surrounding the radiation studies conducted in 1946, 1949, 1954, 1956, 1962 to 1964 at the Fernald State School where children and adolescents were given radioactive substances to ingest as part of a series of nutrition experiments conducted by MIT and Harvard University.</p> <p>Also in Massachusetts, pregnant women were injected with radioactive iron in early 1950s. In 1947 patients given radioactive iodine as part of a thyroid study. Former VA Hospital in Framingham administered radioactive tracers to study metabolism of substances in the body. At Concord State prison in 1961 inmates were given two to five doses of psilocybin.</p>
Doctors of Death	The New York Times January 13, 1994 Thursday	Government radiation experiments on unwitting Americans during the Cold War overlook the sinister element that some of these plutonium injections were conducted to study potential military applications of radiological poisons during war.
Big Scoop For a Little Paper - How the Albuquerque Tribune Broke the Radiation Story	The Washington Post January 8, 1994 Saturday	Eileen Welsome, reporter for the Albuquerque Tribune spent six years researching and interviewing people who were subjects of radiation experiments. The article reports how her story gained national prominence.
For Markey, Belated Vindication; Seven Years Ago, Congressman Fought to Disclose Radiation Testing on Humans	The Boston Globe METRO/REGION; Pg. 17 dtd Dec 30, 1993 Byline: By Michael Rezendes, Globe Staff	<p>Edward Markey has every right to say, "I told you so." Seven years ago - before the recent disclosures that Americans were exposed to radiation during scientific research after World War II - the Democratic Congressman from Malden accused the US government of using disadvantaged citizens in tests of radioactive materials.</p>

TITLE	SOURCE	SYNOPSIS
DMR's Plan for Self-Probe is Assailed	The Boston Globe METRO/REGION; Pg. 17 dtd Dec 30, 1993 Byline: By Doris Sue Wong, Globe Staff	A Massachusetts lawmaker yesterday questioned whether the human radiation experiments on mentally retarded children at the Fernald State School during the 1940's and 1950's should be investigated by the state agency that is charged with overseeing the school.
MIT Official Tells More of Radiation Experiments at Fernald	The Boston Globe METRO/REGION; Pg. 16 dtd Dec 30, 1993 Byline: By Scott Allen, Globe Staff	Officials at the Massachusetts Institute of Technology said yesterday that radiation experiments on mentally retarded residents of the Fernald State School in Waltham continued into the 1960s, but the researchers adopted rules in the last years of the program that strictly limited exposure and required that test subjects be adults.
Americans Secretly Exposed to Horrific Nuclear Tests	Copyright 1993 Southam Inc. Calgary Herald NEWS; Pg A1/FRONT Byline: Simon Tisdall, THE GUARDIAN	The door to a secret chamber of nuclear horrors is slowly being pried open in the United States, revealing government-ordered radiation experiments on retarded children, pregnant women and convicts, plus a range of other clandestine atom-age projects which have shocked and frightened the American public. In the last month, the steady drip of newly released records from the Department of Energy, the agency which has overseen America's military and civilian nuclear complex since the dawn of the nuclear era, has turned into a torrent.
U.S. Radiation Tests: A Human Tragedy	Copyright 1993 Chicago Sun-Times, Inc. Chicago Sun-Times Byline: Editorials	Children below the age of consent, infants, mentally handicapped teens, terminally ill adults -- all made unwitting guinea pigs for testing of radioactive materials.
'50s Student Says He Knew Nothing of Radiation Tests	Copyright 1993 Chicago Sun-Times, Inc. Chicago Sun-Times Dateline: Boston	A man used as a human guinea pig for secret radiation experiments at a school for the mentally retarded says he never was told he was being subjected to atomic testing, according to a published report Wednesday.

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Doctor Likened Test to Nazi Experiments	Copyright 1993 Southam Inc. The Ottawa Citizen Dateline: San Francisco	Who was Dr. Joseph Hamilton, the University of California-Berkeley physician who oversaw injections of radioactive substances into his unwitting patients five decades ago? Was he a noble, competent physician? Or was he an American counterpart to another physician who experimented on patients: Nazi physician Dr. Josef Mengele?
U.S. Atomic Age Took Ugly Turn in 1940s	Copyright 1993 Southam Inc., The Ottawa Citizen Dec 30, 1993, FINAL EDITION Dateline: Washington	Radiation experiments that began in the 1940s put hundreds of unsuspecting Americans at risk. Now, U.S. Energy Minister Hazel O'Leary is on a mission to disclose all of the atrocities.
Biomedical Experimentation Has Its Evil and Chilling Side	Copyright 1993 The San Diego Union-Tribune dtd Dec 30, 1993 SECTION: OPINION	Biomedical experimentation has its evil and chilling side.
Unconscionable Research	Copyright 1993 The Courier-Journal dtd Dec 30, 1993 - METRO Edition SECTION: FORUM; Pg. 8A	The notion of turning unsuspecting people into scientists' guinea pigs is so abhorrent to Americans that our government makes it extremely burdensome to conduct such experiments. New disclosures regarding the deceitful involvement of U.S. officials in such tests a generation ago show why informed consent has come to play a prominent role in human experimentation and why the rigid controls are essential.
America Admits to Nuclear Testing on Retarded Children	Copyright 1993 Associated Newspapers Ltd. Evening Standard dtd Dec 30, 1993 SECTION: Pg. 21 Byline: James Dettmer	Hundreds of Americans were deliberately subjected to high levels of radiation in Cold War-era experiments, the U.S. Government has admitted.

TITLE	SOURCE	SYNOPSIS
More Nuclear Horror Stories	Copyright 1993 The Hartford Courant dtd Dec 30, 1993, A Edition, SECTION: EDITORIAL; Pg. B10	The Clinton administration's release of government records on experiments during the Cold War should shame U.S. nuclear-weapons makers. Clouds of radioactive materials were deliberately and secretly scattered on unsuspecting people.
Retarded Boys Used in U.S. Test on Radioactivity	Copyright 1993 Newspaper Publishing PLC The Independent Dec 30, 1993 SECTION: INTERNATIONAL NEWS PAGE; Page 9 Byline: Peter Pringle	NEW YORK - Teenage schoolboys were fed radioactive breakfast cereal, middle-aged mothers were injected with radioactive plutonium and prisoners had their testicles irradiated - all in the name of science and national security.
It Can't Happen Here, Yet It Did	Copyright 1993 The Atlanta Journal and Constitution dtd Dec 30, 1993 SECTION: EDITORIAL; Section A; Page 12	An appalling truth is emerging. During the first couple of decades of the nuclear age, the U.S. Government authorized a multitude of research programs in which a thousand and perhaps many more unsuspecting Americans were fed or injected with radioactive substances.
HEADLINE: COMING CLEAN; U.S. Should Disclose Its Nuclear Secrets	Copyright 1993 The Dallas Morning News dtd Dec 30, 1993, HOME FINAL EDITION	Slowly, the shroud is being lifted from America's nuclear secrets. And the truth is nothing less than ghastly. In the heat of the Cold War, government researchers subjected hundreds of ill-informed Americans to doses of nuclear radiation.
HEADLINE: News Summary Expanding Radiation Inquiry	Copyright 1993 The New York Times Company The New York Times Dec 30, 1993, Thursday, Late Edition - Final National A15	The Energy Department has expanded its inquiry into the use of human subjects in radiation experiments to determine whether patients in Veterans Administration hospitals were used.

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<p>HEADLINE: Inquiry Into Radiation Tests Extends to Veterans</p>	<p>Copyright 1993 the New York Times Company The New York Times Dec 30, 1993, Thursday, Late Edition - Final SECTION: Section A; Pg 13; Column 1; National Desk</p>	<p>The Energy Department is expanding its inquiry into the improper use of human subjects in radiation experiments to determine whether patients in Veterans Administration hospitals were used, a department official said last night.</p>
<p>HEADLINE: Human Guinea Pig Says He Wasn't Told About Tests</p>	<p>Copyright 1993 Sentinel Communication Co. THE ORLANDO SENTINEL Dec 30, 1993 Thursday, 3 STAR</p>	<p>A man used as a human guinea pig for secret radiation experiments at a school for the mentally retarded says he was never told he was being subjected to atomic testing, according to a published report Wednesday. The former patient, Louis Frankowski, 53, told the Boston Globe he remembers belonging to a "science club" at the Walter E. Fernald State School but said club members were never told they were participating in radiation experiments.</p>